Evaluation of Generalized and Specific Token Reinforcement Using a Paired Stimulus Preference Assessment and Progressive Ratio Schedules

Haily K. Traxler
Western Michigan University, haily.k.traxler@wmich.edu

Follow this and additional works at: https://scholarworks.wmich.edu/masters_theses
Part of the Experimental Analysis of Behavior Commons

Recommended Citation
https://scholarworks.wmich.edu/masters_theses/3708

This Masters Thesis-Open Access is brought to you for free and open access by the Graduate College at ScholarWorks at WMU. It has been accepted for inclusion in Master’s Theses by an authorized administrator of ScholarWorks at WMU. For more information, please contact maira.bundza@wmich.edu.
EVALUATION OF GENERALIZED AND SPECIFIC TOKEN REINFORCEMENT USING A PAIRED STIMULUS PREFERENCE ASSESSMENT AND PROGRESSIVE RATIO SCHEDULES

by

Haily K. Traxler

A thesis submitted to the Graduate College
in partial fulfillment of the requirements
for the degree of Master of Arts
Psychology
Western Michigan University
August 2018

Thesis Committee:

Anthony DeFulio, Ph.D., Chair
Stephanie Peterson, Ph.D.
Cynthia Pietras, Ph.D.
Skinner (1953) stated that the effects of generalized conditioned reinforcers should maintain longer than specific conditioned reinforcers because their effects are not dependent on a particular motivating operation. Tokens easily model different levels of generality because tokens can be paired with one or more back-up reinforcers. In the current study, three types of tokens were assessed that could be exchanged for either salty snacks, food and drinks offered in a small marketplace, or money on a gift card. Token preferences were assessed using a Paired Stimulus preference assessment and a progressive ratio (PR) task. The results of the preference assessment and PR task support that as generality increases, the relative reinforcing value of different types of tokens also increases. The results demonstrate concordance between Paired Stimulus preference assessment and PR tasks in assessing value. Finally, the results support the use of a graded approach to assessing the value of token reinforcers.
ACKNOWLEDGMENTS

I would like to begin by thanking my faculty advisor, Dr. Anthony DeFulio. Through his thoughtful guidance and feedback, I’ve learned a tremendous amount about conducting good research. His mentorship has allowed me to grow as a researcher more than I ever thought possible. I’d also like to thank him for his continued support not only during my thesis, but in grad school. A reminder to make sure I’m getting enough sleep is never delivered at the wrong time.

I’d like to thank my committee members, Dr. Stephanie Peterson and Dr. Cynthia Pietras for their time and contributions to my thesis. It means a lot to me to have guidance from such intelligent individuals in the field.

A special thank you goes to my programmer, Kenny Read. This project would not be what it is today without his assistance building the program. His quick responsiveness to questions and concerns helped make the entire project a success. I can’t thank him enough.

Next, I’d like to thank my lab mates, Sean Regnier, Amanda Devoto, Mark Rzeszutek, and David Sottile. I appreciated all their willingness to help during the project. Their support as colleagues and friends over the last year has meant a lot to me. I’m very fortunate.

Finally, I’d like to thank my family for always being there for me as I’ve taken on this journey. I am forever thankful for their loving patience and support through my entire experience.

Haily K. Traxler
TABLE OF CONTENTS

ACKNOWLEDGMENTS..............................................................................................................ii

LIST OF TABLES............................................................................................................................v

LIST OF FIGURES..........................................................................................................................vi

CHAPTER

1. INTRODUCTION.........................................................................................................................1
   Token Reinforcement....................................................................................................................2
   Token production.........................................................................................................................2
   Exchange production...................................................................................................................3
   Generalized Token Reinforcement..............................................................................................4
   Assessing the Value of a Reinforcer............................................................................................7

2. METHOD....................................................................................................................................12
   Participants and Setting...............................................................................................................12
   Materials...................................................................................................................................12
   Procedures................................................................................................................................13
   Tokens.......................................................................................................................................13
   Preference assessment...............................................................................................................14
   Progressive ratio task...............................................................................................................15
   Token exchange.......................................................................................................................17
Table of Contents – Continued

Data Analysis..................................................................................................................17

3. RESULTS.......................................................................................................................19

Preference Assessment.................................................................................................19
Progressive Ratio.........................................................................................................21

4. DISCUSSION..................................................................................................................35

Limitations.....................................................................................................................36
Future Research.............................................................................................................38
Conclusion.....................................................................................................................42

REFERENCES..................................................................................................................43

APPENDICES

A. Marketplace Menu.....................................................................................................46

B. Participant Set-up Instructions..................................................................................47

C. HSIRB Approval Form...............................................................................................48
LIST OF TABLES

1. Order of token conditions for each participant...........................................13
2. Total tokens earned and exchanged.............................................................24
LIST OF FIGURES

1. Paint-by-Number Game.................................................................16
2. Preference hierarchy in the paired-stimulus preference assessment..................20
3. Average Indifference Point Between Token Comparisons.................................21
4. Progressive Ratio Breakpoints by Token.........................................................22
5. Total Responses per Session.............................................................................25
6. Inter-Response Time..........................................................................................26
7. Inter-Response Time Without Pausing.................................................................27
8. Token-by-Token Average Time per Move – Participants 1-6...............................28
9. Token-by-Token Average Time per Move – Participants 8-11.............................29
10. Token-by-Token Average Time per Move Without Pausing – P1-6......................30
11. Token-by-Token Average Time per move Without Pausing – P9-11...................31
12. Cumulative Records Participant 8......................................................................33
13. Cumulative Records Participant 11.................................................................34
CHAPTER 1
INTRODUCTION

Conditioned reinforcement is among the core principles of behavior analysis. Its use in behavior analysis is widespread, extending across the continuum from basic research to clinical application. It has been well studied since the 1930s and remains a critical area of investigation.

Conditioned reinforcers are stimuli that function as reinforcers due to their association with primary reinforcers. Conditioned reinforcers acquire reinforcing properties in various ways. Pavlovian conditioning describes the process in which stimuli come to elicit and reinforce responses (Williams, 1994). Neutral stimuli acquire reinforcing properties through pairing with primary reinforcers presented contingent on a response. The variables that control primary reinforcers also come to control the neutral stimuli. As a result, neutral stimuli become conditioned reinforcers (Williams, 1994). Thus, a stimulus can become a reinforcer because of its participation in a stimulus-stimulus relation.

Stimuli can also acquire reinforcing value through participation in a three-term contingency (Wyckoff, 1952). Through the observing procedure, discriminative stimuli that signal the availability of reinforcement become conditioned reinforcers. In the observing procedure, two responses are available concurrently. One response produces reinforcement according to a mixed schedule in which an intermittent schedule of food reinforcement is alternated with extinction. The other response, called the “observing response,” produces changes to the color of the response key but does not affect the availability or occurrence of food delivery in any way. Wyckoff demonstrated observing responses were maintained when the stimuli that were presented had a discriminative function (i.e., when differentially correlated with the underlying schedules of reinforcement) but were not maintained when the key colors were
randomly generated and uncorrelated with the underlying schedules. Wyckoff posited that responding maintains under the former arrangement because neutral stimuli presented with reinforcement acquire secondary reinforcing properties. The process is fundamentally the same as in the case of chained schedules of reinforcement. Positive stimuli presented in the appropriate temporal order acquire a secondary reinforcing function for the observing response as well as discriminative function for the terminal response.

**Token Reinforcement**

Stimuli may acquire their reinforcing value due to one or both of the procedures described above. Token reinforcement is a unique form of conditioned reinforcement in that tokens have respondent, discriminative, and reinforcing functions. Tokens first acquire reinforcing value due to pairing with backup reinforcers. Tokens then become discriminative stimuli that signal that reinforcement is available. They robustly maintain behavior and engender patterns of behavior similar to those produced by schedules of primary reinforcement (Kelleher, 1957a,b; 1958, Malagodi, 1967a,b; see Gollub, 1977). In applied settings, tokens are well known as a procedure that offers several advantages, including bridging the delay between a response and the backup reinforcer, maintaining responding when backup reinforcers are not immediately available, allowing sequences of responding to be reinforced without interruption (Kazdin & Bootzin, 1972). There are three main components of token reinforcement procedures: the token-production schedule, exchange-production schedule, and the token exchange schedule (Hackenberg, 2018). The first two of these components have been systematically investigated in basic research studies involving pigeon subjects.

**Token production.** The token-production schedule specifies the schedule requirement for earning tokens (Hackenberg, 2018). That is, the number of responses required to produce a
token. Like other schedules of reinforcement, the token-production schedule often produces recognizable patterns in responding. For example, using a fixed-ratio (FR) schedule, there are two main patterns that typically emerge (see Kelleher, 1958; Malagodi, 1967). First, a “break-run” pattern may occur. This is characterized by post-reinforcement pausing followed by high rates of responding. In a study by Malagodi (1967), rats were trained to deposit tokens for food reinforcers on an FR 20 schedule. Responding remained high and consistent, with brief pausing occurring after reinforcer delivery (Malagodi, 1967). A second pattern that emerges is that as the FR schedule increases, response rates tend to increase at first and then decrease. Chimpanzees were trained to press keys for food on various FR schedules in a study by Kelleher (1958). Response rates were high for low FR schedules (FR 10, FR 20). As FR schedules were increased to FR 30 and FR 60, chimpanzees’ response rates stayed the same or decreased (Kelleher, 1958).

Recognition of these patterns is important for implementing token reinforcement procedures. This is especially important in clinical settings because delays to reinforcement could disrupt the effectiveness of token reinforcement procedures. This is evident when there is a delay between token delivery and exchange (Jackson & Hackenberg, 1996). In a study by Jackson & Hackenberg (1996), pigeons were trained to peck keys resulting in small, immediate reinforcement or large, delayed reinforcement signaled by one or three LED light flashes, respectively. When there was a longer delay between LED flashes and food, pigeons allocated most responding to small immediate reinforcers (Jackson & Hackenberg, 1996). These findings suggest that the delay between token presentation and exchange is critical to the effectiveness of token reinforcement.

**Exchange production.** The exchange production requirement specifies the schedule requirement for entering a period of token exchange. This is akin to a travel cost. In fact, one
early study with rats found that increasing the physical distance between a response lever and a food dispenser resulted in food accumulation prior to bouts of eating (Killeen, 1974). Similar findings have been obtained when exchange production schedules have been manipulated in token reinforcement studies. For example, in a study by Yankelevitz, Bullock, and Hackenberg, (2008), pigeons produced tokens that could be exchanged under variable exchange production schedules. Exchange production schedules ranged between FR 1 and FR 250. Pigeons could save up to twelve tokens per session before an exchange was required. At any point after earning at least one token, pigeons could produce an exchange period. At higher exchange production schedules, pigeons accumulated more tokens before exchanging for back-up reinforcers than at lower exchange production schedules (Yankelevitz et al., 2008).

**Generalized Token Reinforcement**

Tokens that are paired with multiple backup reinforcers are said to be “generalized”. Generalized tokens are thought to be less subject to satiation effects than tokens paired with a single backup reinforcer (Kazdin & Bootzin, 1972). This relates more broadly to the issue of generalized conditioned reinforcement. A generalized conditioned reinforcer is a stimulus that serves a reinforcing function because it has been repeatedly paired with more than one other reinforcer. Skinner (1953) stated that the reinforcing effectiveness, or “value” of generalized conditioned reinforcers should maintain longer than specific conditioned reinforcers because their effects are not dependent on a particular motivating operation. The significance of a generalized conditioned reinforcement depends on the veracity of these claims. Generalized conditioned reinforcement has been widely used in applied settings in forms such as praise and tokens, but the process has only rarely been the subject of systematic laboratory study.
The research comparing the value of specific and generalized token reinforcers has primarily been conducted using non-human animals in laboratory settings (e.g., Andrade & Hackenberg, 2017; DeFulio, Yankelevitz, Bullock, & Hackenberg, 2014; Tan & Hackenberg, 2015). In a study conducted by DeFulio et al. (2014), the value of generalized and specific token reinforcement was evaluated. Pigeons were trained to peck keys to produce either food, water, or generalized tokens. Food and generalized tokens were compared under food restriction conditions. Water and generalized tokens were compared under water restriction conditions. When schedule requirements were the same for both tokens being evaluated in a given session, pigeons produced more generalized tokens than specific tokens. This result provided preliminary evidence that generalized tokens may have more value than specific tokens (DeFulio et al., 2014).

In a follow-up study conducted by Andrade and Hackenberg (2017), specific and generalized token reinforcers were compared in a two-part study in which pigeons could earn three kinds of concurrently available tokens. Pigeons could earn either food tokens (green), generalized tokens on the food panel (white), water tokens (red), or generalized tokens on the water panel (white). In Phase 1, token prices were manipulated in that the response requirement for either the food or water token was increased from FR5 to FR50. All response requirements for generalized tokens remained constant at FR5. As prices for specific tokens increased, pigeons allocated responding to generalized tokens on the opposite panel and exchanged them for the more expensive commodity. For example, when the price of water was increased from FR5 to FR50, pigeons produced generalized tokens on the food panel and exchanged them for water, minimizing the response effort for producing food and water. In Phase 2, production for all tokens remained on an FR5 schedule, but was tested in open or closed economies. Results in the
closed economy were similar to those obtained in Phase 1. In the open economy, overall responding decreased. Most tokens that were produced were exchanged on the food panel. These results support that generalized tokens were preferred over specific when prices for all tokens were low. Additionally, generalized tokens acted as substitutes (i.e., consumption of generalized tokens replaced consumption of specific tokens) when the price of a specific token was increased (Andrade & Hackenberg, 2017).

Generalized token reinforcement has occasionally been studied in applied settings as well. For example, in a study conducted with five students with various developmental disabilities tokens could be earned for hand raising and exchanged for one type of edible backup reinforcer (Moher, Gould, Hegg, & Mahoney, 2008). Responding for tokens was directly related to the motivating operation in effect for the backup reinforcer. As consumption increased, satiation increased, and responding decreased. When tokens were paired with multiple backup reinforcers, satiation slowed, and the effectiveness of tokens maintained longer (Moher et al, 2008). These results provide evidence that generalized conditioned reinforcers may be able maintain responding longer than specific conditioned reinforcers.

While there is a general consensus in the field of behavior analysis that generalized conditioned reinforcers are more valuable than specific, there is no consensus on the best assessment of value. Furthermore, there is no flawless procedure for assessing reinforcer value. Several procedures have been used to assess the value of reinforcers. Procedures that are frequently used include preference assessments, progressive ratio (PR) schedules, and demand analyses, among others. Several studies have focused on evaluating one or more of these procedures. Few studies focus on all three.
**Assessing the Value of a Reinforcer**

Preference assessments are commonly used to identify potential reinforcers for individuals. Among various types of preference assessments are single stimuli, paired stimuli, and multiple stimuli preference assessments (Cooper, Heron, & Heward, 2014). Two commonly used preference assessments include the Multiple Stimulus Without Replacement procedure and the Paired Stimulus procedure. In implementation of the Multiple Stimulus Without Replacement procedure, an array of different items is presented to the individual. The individual makes a selection. The individual is allowed to interact with the item for a small amount of time. Then the item is removed from the array, and the individual is asked to make another choice from the remaining items. The entire process is repeated until each item has been chosen (DeLeon & Iwata, 1996).

The Paired Stimulus preference assessment involves the forced choice between two items presented together out of an array. Individuals are asked to make a selection between the two. Each item is presented with each other item. A hierarchy is developed based on the number of times the individual selects each item over the other items. Stimuli with the highest number of selections are considered the most preferred (DeLeon & Iwata, 1996). Research has been conducted comparing the extent to which the Multiple Stimulus Without Replacement and the Paired Stimulus reliably assess preference. For example, in a study conducted by DeLeon and Iwata (1996), Multiple Stimulus Without Replacement and Paired Stimulus preference assessments were administered with seven participants diagnosed with profound developmental disabilities. Both preference assessments produced consistent results for highly preferred stimuli (DeLeon & Iwata, 1996). An advantage of the Paired Stimulus preference assessment is that direct comparisons of value between each stimulus can be made.
In addition to preference assessments, PR schedules are often used to assess reinforcing value. In a PR task, the response requirement to obtain reinforcement is systematically increased after each delivery of a reinforcer. The final schedule an individual completes to obtain reinforcement is considered the “breakpoint” in responding (Hodos, 1961; Roane, 2008). PR schedules provide information about value in that higher breakpoints indicate higher reinforcing efficacy (Roane, 2008).

Several studies have been conducted that use PR schedules to provide information about reinforcer value. For example, in a study conducted by Sran and Borrero (2010), four typically developing children were given an academic task to complete in order to earn tokens. Tokens could be exchanged for either highest preferred items as determined by a preference assessment (no choice condition), a specific reinforcer of participants’ choice out of an array (specific-choice condition), or combinations of different reinforcers from an array (varied-choice condition). Breakpoints were highest for varied-choice conditions, suggesting preference for more generalized conditioned reinforcement (Sran & Borrero, 2010).

In a study conducted by Russell et al. (2018), preference for specific and generalized reinforcement was evaluated with three children diagnosed with developmental disabilities. Specific reinforcers included edible and leisure items. Generalized reinforcers were tokens exchangeable for either edible or leisure items. Paired stimulus preference assessments were conducted to identify the top three edible and leisure items for each participant. Next, each participant completed math problems on a progressive ratio schedule to earn each of the reinforcers. Response rates were highest to obtain edible reinforcement. However, the highest breakpoints were observed to obtain token reinforcement. Next, participants were given presession access to edible reinforcers. Participants completed progressive ratio tasks to earn
either edibles or tokens exchangeable for edible or leisure items. Following presession access, breakpoints were highest for tokens than for edible items. Tokens were exchanged most often for leisure items. These results suggest that the reinforcing value of generalized tokens is resistant to the effects of disruptive motivational operations.

In a study conducted by Call, Trosclair-Lasserre, Findley, Reavis, and Shillingsburg (2012), Multiple Stimulus Without Replacement, Paired Stimulus, and PR tasks were conducted with seven individuals diagnosed with developmental disabilities. Results of Multiple Stimulus Without Replacement and Paired Stimulus preference assessments were compared and evaluated for consistency with the results of a PR task. The Multiple Stimulus Without Replacement was administered daily while the Paired Stimulus was administered once per participant. Results of the Multiple Stimulus Without Replacement varied across daily administrations. Although both the Multiple Stimulus Without Replacement and Paired Stimulus identified highly preferred items consistent with the PR task, the Paired Stimulus preference assessment predicted highest breakpoints in responding in the PR task to a greater extent than the Multiple Stimulus Without Replacement (Call et al., 2012), suggesting some concordance between PR assessments and paired stimulus assessments of reinforcer value.

Finally, demand analyses are used to assess value through the implementation of fixed ratio (FR) schedules (Hursh & Silberberg, 2008). Unlike the PR task, schedule requirements are systematically increased across sessions. In doing this, consumption can be analyzed as a function of price changes. Price manipulations may be used to compare the value of stimuli relative to each other. The rate at which demand decreases as a function of price increases provides information about a commodity’s value. Commodities for which demand is more resistant to price changes are considered more valuable. Demand curves graphically display
consumption as a function of price. Using demand curves, the value of more than one commodity can be compared. Commodities for which demand remains high as a result of price increases are said to be more valuable than those in which demand quickly decreases with price increases. According to Hursh and Silberberg (2008), demand analyses should be considered superior assessments of value compared to preference tests, as preference outcomes are relative to levels of consumption. There is no direct relationship between the demand analysis and the results of preference assessments (Hursh & Silberberg, 2008).

Few studies have been conducted comparing preference assessments, PR schedules, and demand analyses. However, Tan and Hackenberg (2015) featured a combined approach to assess the value of specific and generalized token reinforcement. Relative values for specific and generalized token reinforcers were evaluated using demand schedules, PR schedules, and Paired Stimulus preference assessments in pigeons. Pigeons were trained to peck keys to produce one of three types of tokens exchangeable for specific or generalized token reinforcers (i.e., food only tokens, water only token, or food and water generalized tokens).

First, a demand analysis was conducted. Fixed ratio (FR) demand schedules were implemented for each token type. Across sessions, the schedule requirement systematically increased until pigeons stopped producing tokens. Demand curves were constructed and analyzed for changes in consumption with respect to price changes. Next, PR schedules were implemented for each token. Within sessions, schedule requirements were systematically increased following production of each token. Breakpoints and the total number of responses were collected. Finally, paired-stimulus preference assessments were conducted comparing each type of token to each other token. In addition to the preference assessments, FR demand
schedules were used in which the two tokens compared were concurrently available and prices of both were manipulated. Total responses and exchanges were recorded.

Results of the demand analysis suggested that consumption was highest for generalized tokens, followed by food tokens, then water tokens. However, peak responding and price tolerance were highest for food tokens, followed by generalized tokens, and finally by water tokens. This suggests that demand for food tokens was the most resistant to price changes. The highest breakpoints in the PR schedules occurred for food tokens, followed by water tokens, and finally by generalized tokens. The highest responding occurred for food tokens, then water tokens, and then generalized tokens. In the preference assessment, when food tokens were compared against water or generalized tokens, food tokens were always preferred. When water tokens and generalized tokens were compared, generalized tokens were preferred. Generalized tokens served as substitutes for food and water tokens, meaning that demand for generalized tokens increased as a result of the increased price of food or water tokens. Across most measures, food tokens were most preferred by pigeons (Tan & Hackenberg, 2015). However, the results produced in each of the assessments were inconsistent.

Attempts to evaluate the value of generalized conditioned reinforcement have yielded variable results. Furthermore, there is limited evidence supporting the critical claim that generalized conditioned reinforcers are more valuable than specific. However, much of this may be attributed to the lack of consistency across value assessment measures. Therefore, the purpose of the current study is to 1) extend the findings by Tan & Hackenberg (2015) to humans; 2) use a graded, rather than dichotomous manipulation of generality; and 3) evaluate the current assessment methods for determining value.
CHAPTER 2

METHOD

Participants and Setting

Ten students who were enrolled at a large Midwestern university participated in this study. Participants were recruited through flyers and in-class announcements. Participants included nine female undergraduate students and one male graduate student. Participants ranged in age between 18 and 35 years old. Participants were included if they could speak and read English and complete basic addition problems. Participants were excluded from the study if they had known food allergies to items used in the study or were colorblind. Relevant eligibility criteria were assessed in a brief screen survey administered after informed consent. All sessions were conducted in a 2.3 m x 3.7 m windowless room that contained a desktop computer, table, and chair. Participants were prohibited from bringing any personal items with them into the room, including books and electronic devices. Participants could receive extra credit for their participation per their course instructors’ preferences.

Materials

All sessions were conducted on a desktop computer with a custom-built computer application. Participants were compensated with edibles (i.e., gum, Doritos®, pretzels, Cheetos®, cookies, fruit snacks, candy, trail mix, jerky, microwave dinners, pop, water, or juice), or money on an Amazon® gift card). Participants were provided with the marketplace menu for all sessions which indicated the available items and prices of each. Compensation was based on performance as described below.
Procedures

Participants completed three sessions. Sessions occurred once a week for three weeks. Each session lasted between 30 min and 3 hrs. During the first session only, participants completed a preference assessment involving three types of tokens described below. During each of the three sessions participants worked on a progressive ratio task involving one of the token types selected randomly without replacement. Each session, participants worked for a token they hadn’t previously worked for. Table 1 displays the order of sessions for each participant.

Table 1

Order of token conditions for each participant.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Token Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Salty Snack</td>
</tr>
<tr>
<td>P03</td>
<td>1</td>
</tr>
<tr>
<td>P11</td>
<td>1</td>
</tr>
<tr>
<td>P04</td>
<td>2</td>
</tr>
<tr>
<td>P01</td>
<td>3</td>
</tr>
<tr>
<td>P09</td>
<td>3</td>
</tr>
<tr>
<td>P02</td>
<td>3</td>
</tr>
<tr>
<td>P05</td>
<td>3</td>
</tr>
<tr>
<td>P06</td>
<td>3</td>
</tr>
<tr>
<td>P08</td>
<td>3</td>
</tr>
<tr>
<td>P10</td>
<td>3</td>
</tr>
</tbody>
</table>

Tokens. Three types of tokens were used in this experiment. Each token could be exchanged for a range of the items offered in the marketplace. Participant preferences for backup reinforcers were not assessed prior to sessions. Motivating operations were not manipulated. The “Salty Snack” token was exchangeable for only salty snacks in the marketplace (i.e., Doritos®, Cheetos®, or pretzels). The “Any Menu Item” token was exchangeable for any of the
consumable items offered in the marketplace (i.e., gum, Doritos®, pretzels, Cheetos®, cookies, fruit snacks, candy, trail mix, jerky, microwave dinners, soft drinks, water, or juice). Tokens exchangeable for consumables were worth approximately 50 cents. The price of each consumable varied based on actual sale prices. For example, a bag of Cheetos® was exchangeable for 3 tokens, equivalent to $1.50. Higher priced items costed more tokens (e.g., microwave dinners were exchangeable for 10 tokens, equivalent to $5.00). Finally, the “Money” token was exchangeable for any of the edible items available in the marketplace and/or money loaded on an Amazon® gift card. The monetary equivalent of one token on an Amazon® gift card was $0.50. Participants were not informed of the true monetary value of tokens.

Preference assessment. A paired stimulus preference assessment was used in this study. The paired stimulus was advantageous in that preference could be assessed in a single session. Initially, tokens were named A, B, and C. However, after participants 1 through 6 completed the preference assessment, token names were changed to Salty Snack, Any Menu Item, and Money, respectively. Token names were changed because it was unclear whether the proper stimulus control was in place to affect differential responding. The use of the paired stimulus preference assessment in the current study was appropriate for calculating indifference points between each token, described below.

Preference assessments were administered during the first session. Token selections in the preference assessment were hypothetical in the sense that participants were asked about their preferences but did not actually receive their selections. The preference assessment was displayed on a dropdown menu that asked participants, “Which would you prefer?” Next, participants made the selection between Salty Snack tokens or Any Menu Item tokens. Once a selection was made, follow-up questions were asked to determine the switch point from the more
preferred to the less preferred token. Based on the initial selection, the number of tokens offered was varied. The amount of the less preferred tokens was adjusted while the amount of the more preferred token was held constant. The initial number of each type of token offered was 500 of the less preferred or 100 of the more preferred. For example, if a participant selected Any Menu Item tokens over Salty Snack tokens, they would then be offered 500 Salty Snack tokens or 100 Any Menu Item tokens. Depending on the selection at that point, the amount of the lesser preferred tokens increased or decreased. If preference remained for the initially more preferred token, the number of less preferred tokens offered was increased. For example, if the participant continued to prefer Any Menu Item tokens over Salty Snack tokens, the amount of Salty Snack tokens increased to 1000 tokens. However, if preference switched between the initially more preferred token to the less preferred token, the number of less preferred tokens offered was decreased. For example, if preference switched to Salty Snack tokens over Any Menu Item tokens, the amount of Salty Snack tokens decreased to 400. The number of tokens offered was adjusted in this fashion across a series of questions to determine the exact indifference point. The indifference point was the number of tokens offered that resulted in a switch of preference. This procedure was repeated to compare each token with all others.

**Progressive ratio task.** Following the preference assessment, participants completed a progressive ratio (PR) task which was delivered in the form of a computerized Paint-by-Number game. During sessions, participants were provided with the marketplace menu. A screenshot of the game is shown in Figure 1. The game was set up as a 5x10 grid of squares. Each square contained a simple addition problem. To the left of the puzzle was a panel of six colors that contained ranges of numbers. Ranges of numbers corresponded with the sums of the addition problems. Participants dragged and dropped colors from the left panel into boxes to color the
puzzle. If the participant dropped the correct color into a square, the square was colored. If the participant dropped an incorrect color, the square remained uncolored and no change was recorded. When an entire puzzle was colored, a new puzzle would appear immediately. The progressive ratio step size was always five (i.e., the schedule of reinforcement was a PR5). Thus, each time a new puzzle appeared it was five squares larger than the previous puzzle. Participants earned one token for completing each puzzle. Sessions ended when participants selected “Finish” on the game screen, were inactive for 5 minutes, or earned 30 tokens. Each token was worth 50 cents. Participants could earn up to $15 worth of each token.

*Figure 1. Paint-by-Number Game.*

To control for the speed at which puzzles were completed, two controls were put in place. First, no recognizable patterns were used to make up the display of each completed puzzle. By using unrecognizable patterns, participants could not use cues from the image to facilitate their task completion. Furthermore, this reduced the chance that the task itself would have reinforcing effects that may have occurred due to pattern recognition.
Second, math problems were used because they were more effortful and more engaging than other arbitrary responses such as button pressing, but simple enough that the level of difficulty should not have differed substantially across participants. Use of a response that was more effortful reduced the rate of responding and allowed for a smaller step size in the PR task. A smaller step size allowed for a more precise description of the breakpoint in responding.

**Token exchange.** Participants were required to exchange tokens the same day they were earned. At the conclusion of each session, the researcher recorded the number of tokens earned. Participants were shown the marketplace menu indicating the array of items in the market. They could exchange tokens for combinations of items. Exchanges corresponded with the token earned during the session up to the number of tokens earned. Participants were not required to spend all their tokens. Any tokens not spent did not roll over to subsequent sessions. See Appendix A for the marketplace menu with prices of items.

**Data Analysis**

Data were analyzed using visual analysis of graphs and descriptive statistics. For the preference assessment, a hierarchy of token preference was generated. Indifference points were collected and graphically analyzed. Descriptive statistics were used to analyze differences.

For the PR task, breakpoints, cumulative responses, and response rates were measured. The breakpoint was defined as the final schedule requirement completed for each token. Breakpoints were measured to provide information about the value of each token relative to the others. Cumulative responding was recorded to determine the total number of responses emitted for each type of token. By measuring cumulative responding, observations about the response patterns could be collected, such as the point at which the final response was emitted (e.g., at the end of a puzzle; part way through a puzzle). Response rates were evaluated to assess patterns in
responding, such as post-reinforcement pausing and changes in rates of responding within or across schedule requirements. Response rates were recorded for overall session rates and token-by-token rates. A record of the items purchased was analyzed to determine whether participants would exchange generalized tokens for items purchasable with specific tokens.

Results of the preference assessment and progressive ratio tasks were compared. The reliability of each of these procedures in providing information about preference and reinforcer value was evaluated. The order of preference predicted by each procedure was analyzed for consistency.
Preference Assessment

Figure 2 shows the preference hierarchy. Preference for tokens increased with increasing generality. Specifically, the most preferred token was the Money token, followed by the Any Menu Item token. The Salty Snack token was the least preferred. For each paired stimulus comparison, an indifference point was determined. Figure 3 displays the mean indifference points for each of the comparisons. Indifference points indicate the number of less preferred tokens required to switch in preference from the more preferred token to the less preferred. Higher indifference points between tokens indicate higher potency of the more preferred token as a reinforcer. A starting value of 100 of each token was offered. The number of less preferred tokens was increased while the number of more preferred remained at 100. Indifference points were highest when either the Any Menu Item or Salty Snack tokens were compared against Money tokens. Indifference points were substantially higher in comparisons against Money tokens than in the comparison of Salty Snack and Any Menu Item tokens. The highest indifference point was found when Any Menu Item tokens were compared against Money tokens ($M=4341$, $SD=4483$). That is, when 100 of the more preferred tokens were offered, participants’ preference did not switch to the less preferred until an average of 4341 less preferred tokens were offered. The next highest indifference points were found when Salty Snack and Money tokens were compared ($M=4431$, $SD=4122$), followed by Salty Snack versus Any Menu Item ($M=2242$, $SD=4213$).
Figure 2. Preference hierarchy in the paired-stimulus preference assessment.
Progressive Ratio

The use of Money tokens as the consequence for ratio completion resulted in the largest breakpoints for 9 out of 10 participants. The lowest breakpoints were produced when Salty Snack tokens were made contingent on ratio completion for 7 out of 10 participants. Figure 4 shows the average breakpoints in responding to the PR task with individual scores for each token type. The highest average breakpoint was observed for the Money token (M=149, SD=28.1). Individual breakpoints for the Money token ranged from 95 to 180. Individual breakpoints were highest for the Money tokens for 9 of 10 participants. The next highest average breakpoint was observed for the Any Menu Item token (M=119, SD=34.5). Individual breakpoints ranged from 80 to 195. Finally, the lowest average breakpoint was observed for the Salty Snack token (M=103, SD=17.7). Individual breakpoints ranged from 75 to 135. When using Any Menu Item
tokens a consequence for completing a ratio, 7 out of 10 participants’ breakpoints were higher than or equal to their breakpoints when Salty Snacks were used. One participant’s highest breakpoint occurred for the Any Menu Item token. Varied preference between Salty Snack and Any Menu Item tokens is consistent with the low indifference point collected for the comparison of the two.

Figure 4. Progressive Ratio Breakpoints by Token.

Table 2 displays the item exchanges made following the progressive ratio task. Participants exchanged Salty Snack tokens for each of the available items approximately equally. For the Any Menu Item tokens, exchanges were made across a variety of backup reinforcers. The highest number of Any Menu Item tokens were exchanged for trail mix. No participants
exchanged Any Menu Item tokens for water. Several participants used Any Menu Item tokens to purchase Doritos and Cheetos, which were also available for purchase with the Salty Snack token. No participants exchanged Money tokens for any items except for money on an Amazon© gift card.
Table 2

*Total tokens earned and exchanged.*

<table>
<thead>
<tr>
<th>Salty Snack Token</th>
<th>Item</th>
<th>Price (tokens)</th>
<th>Number Purchased</th>
<th>Tokens Exchanged</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Doritos</td>
<td>3</td>
<td>13</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Pretzels</td>
<td>3</td>
<td>13</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Cheetos</td>
<td>3</td>
<td>12</td>
<td>36</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Any Menu Item Token</th>
<th>Item</th>
<th>Price</th>
<th>Number Purchased</th>
<th>Tokens Exchanged</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trail Mix</td>
<td>4</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Gum</td>
<td>3</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Candy</td>
<td>3</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Cookies</td>
<td>3</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Jerky</td>
<td>4</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Cheetos</td>
<td>3</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Doritos</td>
<td>3</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Pop</td>
<td>3</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Microwave Dinner</td>
<td>10</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Pretzels</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Candy</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Cookies</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Doritos</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Cheetos</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Jerky</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Pop</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Pretzels</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Fruit Snacks</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Money Token</th>
<th>Item</th>
<th>Price</th>
<th>Number Purchased</th>
<th>Tokens Exchanged</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Money ($0.50)</td>
<td>1</td>
<td>103</td>
<td>206</td>
</tr>
<tr>
<td></td>
<td>Gum</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Trail Mix</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Candy</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Cookies</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Doritos</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Cheetos</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Jerky</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Pop</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Pretzels</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Fruit Snacks</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Microwave Dinner</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Juice</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The average number of responses per session was collected. On average, the highest number of responses occurred for the Money token ($M=2229$, $SD=883$), followed by the Any
Menu Item token ($M=1355$, $SD=960$), and the Salty Snack token ($M=963$, $SD=383$). Figure 5 displays total responses for each participant in each condition.

![Bar chart showing total responses per session for each participant across different conditions.]

*Figure 5. Total Responses per Session.*

The average inter-response time was collected for each participant in each condition, displayed in Figure 6. Response times were highest for the Any Menu Item token ($M=2.8$ s, $SD=1.3$ s), followed by the Salty Snack token ($M=2.7$ s, $SD=0.8$ s), and the Money token ($M=2.5$ s, $SD=0.5$ s). Further analyses were conducted in which pauses greater than 8-seconds were removed from the data. Pauses greater than 8-seconds were removed because pauses greater than or equal to 8-seconds were uncommon in the data across participants. Figure 7 displays inter-response times with pausing removed. Removing pauses greater than 8-seconds produced average response times that were about half of those produced with pausing included. By
removing pauses greater than 8-seconds, average response times were not affected by long, uncommon pauses and may be more representative of pacing during sessions. The average inter-response time for each token was collected for each participant. Token-by-token averages for each participant are displayed in Figures 8 and 9. Token-by-token averages with pausing removed are displayed in Figures 10 and 11. Removing pausing from the data produced less variability in inter-response times.

Figure 6. Inter-Response Time.
Figure 7. Inter-Response Time Without Pausing.
Figure 8. Token-by-Token Average Time per Move – Participants 1-6.
Figure 9. Token-by-token Average Time per Move – Participants 8-11.
Figure 10. Token-by-Token Average Time per Move Without Pausing P1-6.
Finally, cumulative records were created displaying cumulative responses and changes in response rates. Figures 12 and 13 display cumulative records for participants with notable response patterns (Participants 8 and 11, respectively). Cumulative records were produced for the first 1500 moves participants completed in each session. Cumulative record curves reset every 200 seconds in the session. Participant 8 engaged in quickest responding in the first 1500 moves for the Salty Snack tokens, followed by the Any Menu Item token, and then Money tokens. Post-reinforcement pausing occurred for about four out of nine Salty Snack tokens. However, only about one instance of post-reinforcement pausing occurred for either than Any Menu Item or Money tokens within the first 1500 moves.

Figure 11. Toke-by-Token Average Time per move Without Pausing – P9-11.
Participant 11 engaged in little post-reinforcement pausing in any sessions. In the Salty Snack condition, slight pauses occurred for one token within the first 1500 moves. In the Any Menu Item condition, post-reinforcement pausing occurred following the delivery of two out of nine tokens. Very slight pausing occurred for one token in the Money condition. While Participant 8 tended to respond quicker for less generalized tokens, Participant 11 displayed quickest response rates as generality increased. Participant 8 produced the most tokens under the Salty Snack condition within 1500 moves, followed by Any Menu Item, then Money. Participant 11 produced the most tokens under the Money condition within 1500 moves, followed by Any Menu Item, and Salty Snacks.
Figure 12. Cumulative Records Participant 8.
Figure 13. Cumulative Records Participant 11.
The results of this study suggest that relative reinforcer value of different kinds of tokens increases as the generality of the tokens increases. These results support Skinner’s (1953) claim that generalized conditioned reinforcers are more valuable conditioned reinforcers that derive their reinforcing function from their relation to a single backup reinforcer. Importantly, the present results also indicate that the relationship between reinforcer generality and reinforcer value is graded. Lastly, the results also demonstrate concordance between reinforcer value as measured in a hypothetical preference assessment task and a progressive ratio task in which the type of tokens available for completing ratios differed on the dimension of generality.

While these results support Skinner’s claim, they differ from those found in the study conducted by Tan and Hackenberg (2015) with pigeon subjects. In that study food tokens were most preferred, followed by generalized (exchangeable for food or water), and water tokens were the least preferred. Preference was consistently highest for food tokens in the FR demand analysis, PR, and preference assessment conditions. However, only the FR demand analysis and preference assessment consistently produced results suggesting that generalized tokens were second preferred and water least preferred. Results of the PR task suggested that generalized tokens were least preferred. Thus, Tan and Hackenberg did not obtain the orderly and graded relationship between reinforcer value and reinforcer generality that was obtained in the present study with humans. Procedural differences, rather than species, appear to be the most likely source of the differences in the findings of the present study and those of Tan and Hackenberg (2015).
While motivational operations were manipulated in Tan and Hackenberg (2015), no deprivation procedures were conducted in the present study. It is possible that pigeons were unintentionally deprived of food to a greater extent than water, influencing preference. This is evident in that food tokens were consistently highest preferred across all three assessments. The current results differ in that preference increased with generality, independent of motivating operations. Preference remained highest for the Money tokens with 9 out of 10 participants displaying higher breakpoints for Money tokens than Salty Snack or Any Menu Item tokens.

In addition to differences in motivational operations, the current study differs from Tan and Hackenberg’s (2015) study in that a graded rather than dichotomous analysis of generality was used. In Tan and Hackenberg’s study, two of the three tokens represented specific reinforcers and only one represented generalized. In this way, it was impossible to tell whether gradual increases in generality resulted in higher preferences. This limits the implications of the study in that different levels of generality could not be assessed. Given that preference for the generalized token was often couched between specific tokens, it was difficult to draw conclusions about the value of generalized tokens. In the current study, three levels of generality were assessed, eliminating the possibility of a generalized token being couched between two specific tokens. The number of backup reinforcers available for each token was gradually increased. Increasingly generalized tokens were exchangeable for all backup reinforcers available for less generalized tokens. The current study also provided clearer hierarchies of the relative value of generalized conditioned reinforcers.

**Limitations**

Various limitations may have impacted the results of this study. First, it was unclear whether participants understood the instructions for the preference assessment. Before sessions
began, the researcher briefly explained the preference assessment, informed participants of the
token they’d be working for (including the commodities it could be exchanged for), and then left
the room for the rest of the session (see Appendix B for session set-up instructions). From then
on, participants were dependent on prompts from the program to complete the preference
assessment. For participants 1 through 6, tokens in the preference assessment were named A, B,
and C. Because the token names were vague, participants may have been unclear about what the
tokens represented. Although participants had access to a description of each of the tokens,
changing the names of the tokens to Salty Snack, Any Menu Item, or Money resulted in more
robust differences in preference for the remaining participants. Indifference points were larger
after the change was made. Future extensions of this study should include the more descriptive
token names.

An additional limitation to the study was that the opportunity to earn extra credit for
participating may have influenced the length of time participants spent in sessions. At the end of
sessions, participants could request an extra credit slip from the experimenter that indicated the
length of participation that day. The participants who requested extra credit slips were not
documented. It is possible that the length of participation in each session was influenced by the
possibility of earning extra credit. However, because there was no documentation of participants
who earned extra credit, it is not possible to determine whether the length of sessions was related
to earning extra credit. Future extensions should include documentation of participants who
earned extra credit, or the elimination of extra credit as a possibility for participating.

It is possible but unlikely that program malfunctions may have impacted responding in
the Paint-by-Number game. Differences in the maximum number of responses in a session were
sometimes observed. Due to internet connection glitches, the program occasionally did not
register a move when a tile was filled. This resulted in an additional one to four moves
requirements to complete Paint-by-Number puzzles under some circumstances. While on most
occasions, internet connection issues were minor, they disrupted Participant 10’s Any Menu Item
session. After Participant 10 earned fifteen tokens, the internet stopped working. The participant
was given the option to exchange the tokens or start the game over. The participant chose to start
the game over. However, on the second attempt while working toward the fourth token, the
puzzle ended abruptly. When about half of the tiles had been filled, the next puzzle was
automatically generated. To avoid internet connection issues, the use of a program that does not
rely on internet connection should be considered.

Another computer program issue was that participants were given access to the menu
screen where token selections were made at the beginning of sessions. Because of this,
participants had an opportunity to manipulate the game in favor of their preferences. After
entering the relevant information into the menu, the researcher would leave the room, allowing
the participant to click “Submit” and begin the game when they were ready. When left alone in
the session room, Participant 8 changed the assigned token from the Salty Snack to the Any
Menu Item (they completed the Money token condition in a prior session). While this was the
only instance of a participant manipulating the token choice, future researchers should consider
limiting participants’ ability to manipulate the game.

Future Research

First and foremost, future research should extend the findings of the FR demand analysis
that FR demand analyses are superior assessments of value to PR tasks and preference
assessments. An FR demand analysis provides a quantitative analysis of value by providing
information about changes in demand relative to price (i.e., elasticity) and relative consumption. Elasticity is the refers to the sensitivity to price changes of a given commodity. An elastic commodity is one in which consumption drops quickly as a result of price increases. In contrast, an inelastic commodity is one in which consumption remains high as price increases. Price manipulations, as opposed to motivating operations

By conducting price manipulations, information about substitutability and complementarity can be obtained. If consumption of one commodity increases as the price of the other increases, the two commodities are considered substitutes. If consumption of one commodity decreases as the price of the other increases, the two commodities are considered complements. A demand curve graphically displays consumption as a function of price. Steeper demand curves indicate more elasticity. Essential value is the rate of change in elasticity at a given point on the demand curve.

The essential value is calculated as an index of reinforcer strength. Essential value is the measure of value independent of reinforcer magnitude and potency. A higher essential value indicates higher inelasticity and less sensitivity to price changes. A reinforcer with a higher essential value has greater reinforcer strength because responding can be maintained for longer. Together, the results of a demand analysis provide an in-depth analysis of value relative to price changes. If results produced with an FR demand analysis are consistent with the current findings, there is additional evidence validating the results of the current study.

Future research should also expand on Tan and Hackenberg’s (2015) study by using a graded rather than dichotomous approach for evaluating reinforcer value in non-human animals. Rather than use two specific and one generalized token to evaluate reinforcer value, three tokens representing increasing levels of generality should be used. Pigeons in the study by Tan &
Hackenberg (2015) responded least for water tokens in the preference assessment and FR demand analysis. Preference for generalized tokens was couched between two specific, making it difficult to draw conclusions from the results. By using tokens of increasing generality, errors due to unequal deprivation states may be reduced. In addition, if results of a replication using non-human animals are consistent with the current findings, there is additional evidence to support the use of a graded approach to generality.

Next, future research should focus on manipulating token accumulation. Token accumulation is often observed when the exchange-production schedule is manipulated. For example, in a study by Killeen (1974), when the response effort for obtaining reinforcement was increased (i.e., the exchange schedule was manipulated), rats accumulated more food pellets before consumption. Given the results of the current study, it would be interesting to evaluate whether individuals will accumulate more specific or generalized tokens with manipulations to the exchange-production schedule. These results may provide important implications about wealth accumulation as it relates to generalized conditioned reinforcement. Patterns in saving and spending generalized and specific tokens may be assessed. These patterns may provide useful information about how humans save and spend money based on its utility.

Future directions for research should include manipulations of backup reinforcement. There is value in conducting preference assessments prior to sessions in that responding may be differentially influenced by preference for back-up reinforcement. In the study conducted by Russell et al. (2018), preference assessments were used to identify participants’ top three edible and leisure items. The top three highest preferred in each category were then used as reinforcers for completing the PR task. Response rates were highest for edible reinforcers. Tokens were most often exchanged for edible reinforcers when presession access to edibles was not given but
exchanged for leisure items after presession access to edibles. (Russell et al., 2018). Conducting a preference assessment for all back-up reinforcers prior to sessions would provide a hierarchy of reinforcers for each participant that could allow for individualized tokens. By using highly preferred items as back-up reinforcers, participants may respond to obtain more reinforcement. However, using moderately preferred items may control for the differential effects of highly preferred back-up reinforcement. It would be interesting to evaluate whether preference remains highest for generalized conditioned reinforcers with manipulations to back-up reinforcement. If preference remains highest for generalized conditioned reinforcers, there is additional support for Skinner’s claim that generalized conditioned reinforcers are more valuable than specific.

In addition to allowing participants’ preference to inform backup reinforcement, future studies should include assessments of participants’ motivational states. Assessing motivational states may provide information about token preferences throughout the course of the study. For example, if a participant reports hunger during a session, they may complete more ratios than on a day in which they report less hunger. This could impact results in that participants may work harder for a less generalized token due to changes in motivation. Consideration of motivating operations also may provide additional evidence for the value of generalized tokens if the hierarchy of preference remains consistent with the results of the current study, regardless of deprivation.

In the current study, the number of hypothetical tokens of each type offered in the preference assessment was inflated compared to the number of tokens available in the progressive ratio task. In future studies, the number of hypothetical tokens offered should be closely matched with the number of possible tokens in the progressive ratio task. In doing this,
the true value of a token may be reflected more clearly. Therefore, responding may represent true preference better than using inflated numbers.

Conclusion

Taken together, the results of the current study support that as generality increases, the relative reinforcer value of different types of tokens also increases. The current study provides evidence for the use of a graded approach to evaluating reinforcer value. Finally, the current study also demonstrates correspondence between the use of a hypothetical preference assessment task and a progressive ratio task in evaluating the reinforcing value of tokens representing different levels of generality. These results support Skinner’s (1953) claim that generalized conditioned reinforcers are more valuable than specific, though further research is needed to address limitations and further evaluate this claim.
REFERENCES


Appendix A

Marketplace Menu

**Tokens:**
- **A - Salty Snack Token:** exchangeable for *salty snacks* in the marketplace.
- **B - Any Menu Item Token:** exchangeable for *any item* in the marketplace.
- **C - Money Token:** exchangeable for *any item* in the marketplace OR *money* on a gift card.

**Marketplace Menu:**

<table>
<thead>
<tr>
<th>What is the item?</th>
<th>What is the price?</th>
<th>What tokens can I use to buy this?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gum</td>
<td>2 tokens</td>
<td>B, C</td>
</tr>
<tr>
<td>Doritos</td>
<td>3 tokens</td>
<td>A, B, C</td>
</tr>
<tr>
<td>Pretzels</td>
<td>3 tokens</td>
<td>A, B, C</td>
</tr>
<tr>
<td>Cheetos</td>
<td>3 tokens</td>
<td>A, B, C</td>
</tr>
<tr>
<td>Cookies</td>
<td>3 tokens</td>
<td>B, C</td>
</tr>
<tr>
<td>Fruit Snacks</td>
<td>3 tokens</td>
<td>B, C</td>
</tr>
<tr>
<td>Candy</td>
<td>3 tokens</td>
<td>B, C</td>
</tr>
<tr>
<td>Trail Mix</td>
<td>4 tokens</td>
<td>B, C</td>
</tr>
<tr>
<td>Jerky</td>
<td>4 tokens</td>
<td>B, C</td>
</tr>
<tr>
<td>Microwave Dinner</td>
<td>10 tokens</td>
<td>B, C</td>
</tr>
<tr>
<td>Pop</td>
<td>3 tokens</td>
<td>B, C</td>
</tr>
<tr>
<td>Water</td>
<td>3 tokens</td>
<td>B, C</td>
</tr>
<tr>
<td>Juice</td>
<td>5 tokens</td>
<td>B, C</td>
</tr>
</tbody>
</table>
Appendix B

Participant Set-up Instructions

1. Greet participant and take them into the experimental room.
2. Read informed consent document with participant.
   a. Have participant sign the informed consent.
   b. Set up the Informed Consent quiz on Qualtrics and allow participant to complete.
      i. If the participant passes with >70%, administer the brief screen.
      ii. If the participant does not pass with >70%, administer quiz again.
         1. If participant passes, administer brief screen.
         2. If participant does not pass, let them know they are not eligible to complete the study.
3. Administer the brief screen
   a. Check participant’s answers
      i. If they meet inclusion criteria (i.e., not allergic to food items included in study, able to complete basic math problems, able to speak/read English), set up the Paint-by-Number program.
      ii. If they do not meet inclusion criteria, let them know they are not eligible to complete the study.
4. Set up the Paint-by-Number game.
   a. Enter participant ID and token type based on random selection
   b. Give instructions for the preference assessment and progressive ratio task
5. Preference Assessment Instructions
   a. Let participant know they’ll be asked to indicate their preference between each token offered against each other token
   b. Explain that the number of tokens will be adjusted based on their initial selection and that they should keep indicating preference based on the number offered and preferred
   c. Inform participant that the Paint-by-Number game will begin immediately after the preference assessment
6. Progressive Ratio Task Instructions
   a. Tell participant that they can drag and drop from the left panel into boxes that correspond to the sums in the panel
   b. Let participant know that they can hit finish whenever they decide they do not want to play anymore
   c. Let participant know that they are not required to be in the room for a specific amount of time and may quit whenever they want
   d. Let participant know that the game will eventually time out for non-activity, but it is not likely to happen
   e. Tell participant that a final way to end the game is to max out the number of tokens they can earn, but do not let them know how many tokens
Date: August 23, 2017

To: Anthony DeFulio, Principal Investigator
    Haily Traxler, Student Investigator for Thesis

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number 17-08-04

This letter will serve as confirmation that your research project titled “Evaluation of Generalized and Specific Token Reinforcement Using a Paired Stimulus Preference Assessment and Progressive Ratio Schedules” has been approved under the expedited category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note: This research may only be conducted exactly in the form it was approved. You must seek specific board approval for any changes in this project (e.g., you must request a post approval change to enroll subjects beyond the number stated in your application under “Number of subjects you want to complete the study”). Failure to obtain approval for changes will result in a protocol deviation. In addition, if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

Reapproval of the project is required if it extends beyond the termination date stated below.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: August 22, 2018